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ORGANIZATION SERIES

Lewis Research Center

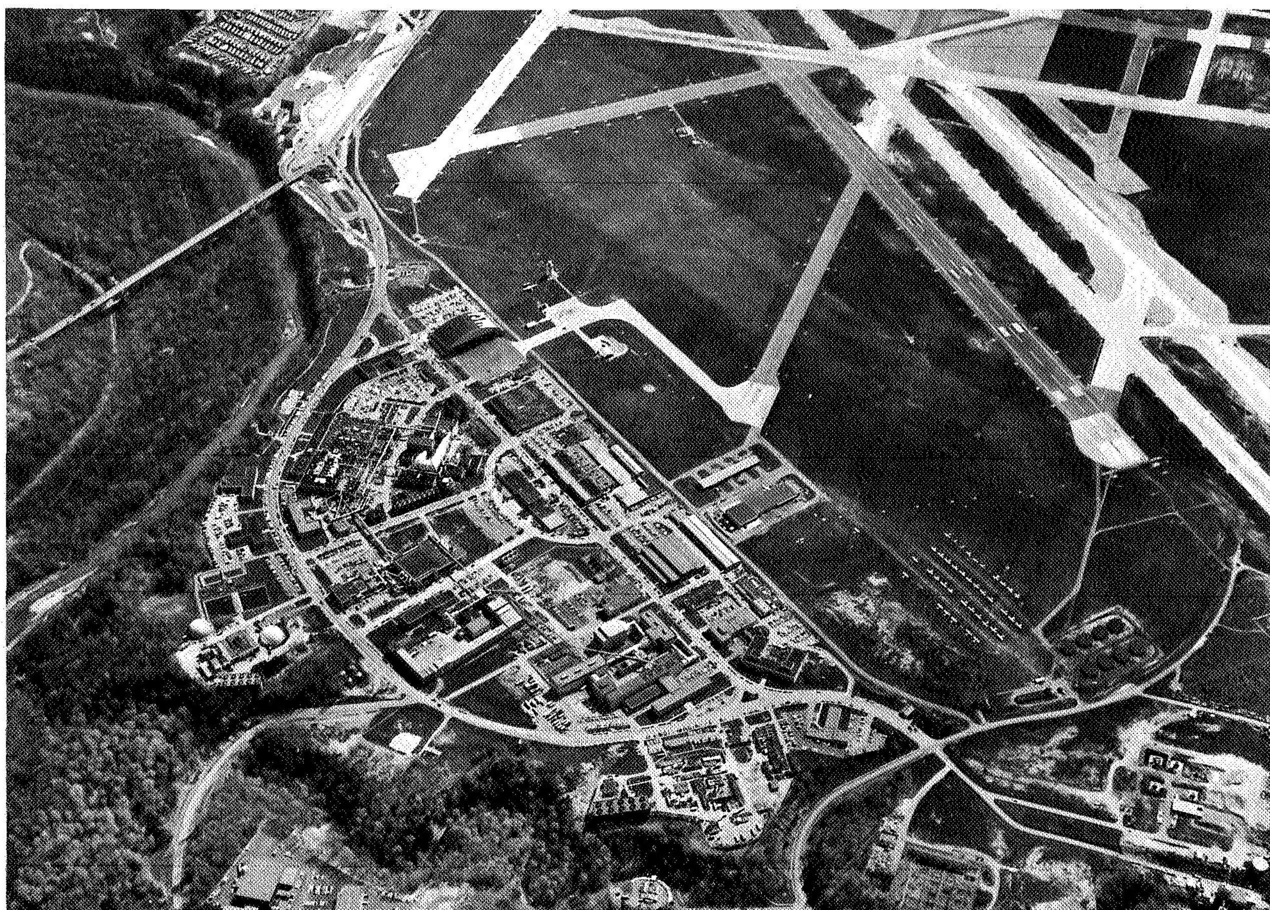
CLEVELAND, OHIO

Research in propulsion and in electrical power generation are the primary tasks of the National Aeronautics and Space Administration's Lewis Research Center.

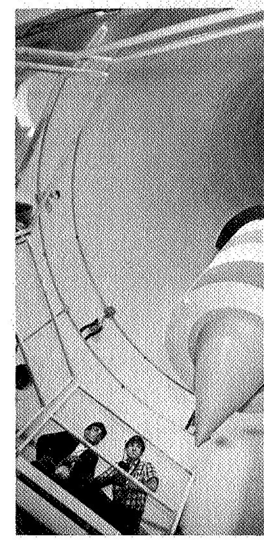
Construction of Lewis was begun in 1941 by the National Advisory Committee for Aeronautics, NASA's predecessor. Today the Center occupies 350 acres in Cleveland and 6,000 acres at the Plum Brook Station located about 50 miles from Cleveland near Sandusky, Ohio. The staff at these two locations numbers about 4,800, including almost 2,000 engineers and scientists. About 550 persons are employed at Plum Brook.

The Center also manages several of NASA's

The Lewis Research Center in Cleveland, Ohio, is a major propulsion facility of the National Aeronautics and Space Administration.



Lewis Research Center is studying advanced air-breathing propulsion systems for applications to future aircraft. Here, a research engineer examines an external compression inlet mounted for environmental testing in Lewis' 10x10-foot supersonic wind tunnel. In addition to engine component studies such as this inlet program, the Lewis center is conducting research on other problem areas including lubrication and cooling, materials, noise, fuel ignition and fuel stability.



medium weight launch vehicles used for unmanned scientific missions including the Atlas-Centaur, Atlas-Agena and Thor-Agena. Lewis was responsible for the successful development of the Centaur vehicle which pioneered in liquid hydrogen technology, and for developing a standardization program for Atlas boosters used with Centaur and Agena upper stages.

The Lewis Center is oriented to advancing the technology of chemical, nuclear and electric rockets, air-breathing engines, and of space electric power systems for a wide spectrum of power requirements. Included in this work is the background research and technology in metallurgy, basic chemistry, plasma physics, fuels, fluid flow, heat transfer, electronics, control dynamics, nucleonics and other areas pertinent to propulsion and power generation systems.

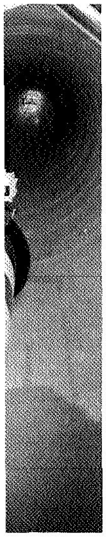
Lewis, originally known as the Aircraft Engine Research Laboratory, was renamed the Lewis Flight Propulsion Laboratory in 1948 in honor of Dr. George W. Lewis, former NACA Director of Aeronautical Research. The Center became the Lewis Research Center in 1958 when NASA was created by Congress.

During World War II Lewis' efforts were directed toward problems concerned with improving the performance of U.S. military aircraft. Achievements included: development of fuel components which greatly increased the amount of 100 octane aviation gasoline available; development of water injection systems to increase the power of aircraft engines; and key contributions toward the development of turbo superchargers.

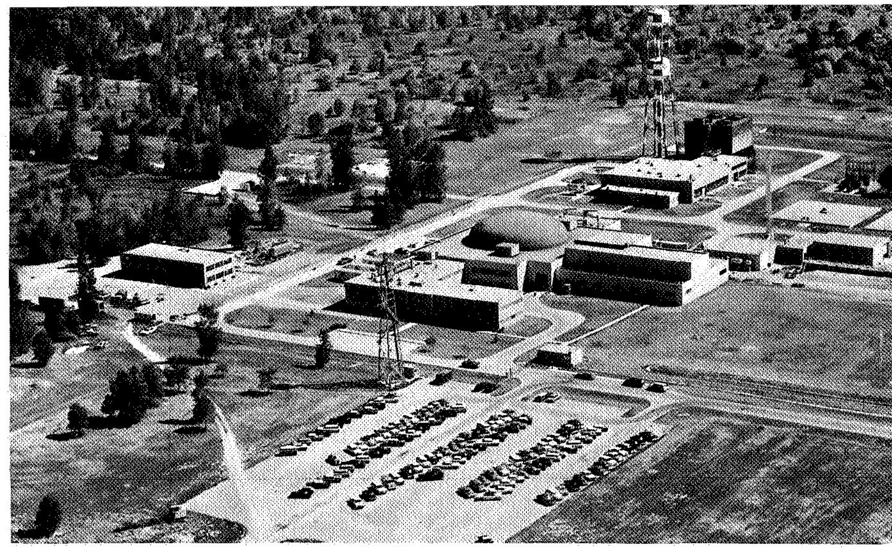
After the war Lewis' work was primarily concerned with turbojet propulsion. During this era, the Lewis staff pioneered many important jet innovations and designs: thrust reversal devices, turbojet afterburners, high altitude compressors, supersonic inlets, and transonic compressors. By the time commercial jet service was initiated, virtually every propulsion system in military and commercial jet aircraft had been put through its paces in Lewis research facilities.

The Lewis staff was also involved in rocket propulsion research and by the late 1940's Lewis engineers were moving beyond conventional rocketry into high-energy propulsion systems using liquid hydrogen, hydrazine, diborane and liquid fluorine. By the mid 1950's, Lewis engineers had successfully tested a 5,000-lb. thrust hydrogen-fueled engine, thus paving the way for the propulsion technology that made possible current U.S. plans to land men on the moon. Hydrogen proved to be the ultimate fuel necessary to accomplish missions of the 1960's and 1970's.

Lewis' Plum Brook Station was established by the NACA in 1956 following a decision to construct a research reactor to study problems associated with nuclear propulsion. The 60,000 kilowatt re-



Technicians inspect a 1,500-lb. experiment being prepared for testing in Lewis' 510-foot deep Zero Gravity Research Facility. The facility is used to augment research on fluids in a weightless environment. The shaft is 28 feet in diameter. By dropping experiments from the top, five seconds of weightlessness can be produced. This zero-G time is doubled when experiments are propelled upwards from the bottom by a high-pressure accelerator, permitted to fall free, then retrieved by a large decelerator cart. The facility can handle experiments weighing up to 6,000 lbs.



This shows the Plum Brook 60-megawatt research reactor facility. Built on a 6,000-acre site, the reactor is being used for numerous basic physics, materials and components tests leading to the development of a nuclear rocket engine system.

actor went into operation in 1963 and is currently used in support of the U.S. program to develop a nuclear rocket for space exploration. Other work at Plum Brook involves test programs of rocket engine systems, components and high-energy fuels.

Lewis' largest single development effort is the hydrogen-fueled Centaur upper stage, which is boosted by an Atlas. Centaur, which completed the first successful flight of a vehicle fueled with high-energy propellants in 1963, was developed to launch the Surveyor spacecraft to the moon to study potential landing sites for U.S. astronauts. Centaur also has been selected to launch the Applications Technology Satellite, Orbiting Astronomical Observatory and the Mariner Mars 1969 mission.

The Atlas-Agena vehicle, also a Lewis-managed project, has demonstrated its effectiveness during many NASA scientific space missions: the Ranger spacecraft which returned our first close-up photos of the Moon; the Mariner II and V spacecraft which flew past Venus in 1962 and 1967; Mariner IV which made our first successful flyby of Mars in 1965; the Lunar Orbiter spacecraft which are systematically mapping the Moon; and a series of Orbiting Geophysical and Astronomical Observatories.

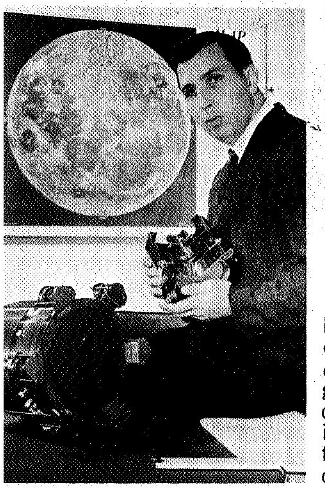
Lewis propulsion efforts in chemical rocketry are not restricted to liquids. The Center also has managed the 260-inch diameter solid propellant motor research program during which three ground firing tests were conducted. The third firing in 1967 produced more than 5.6 million pounds of thrust.

The Lewis Center also is supporting the joint NASA-Atomic Energy Commission program to develop a nuclear rocket, and is conducting pioneering work in electric propulsion. Objective of these advanced systems is to use propellants more efficiently than chemical rockets; that is, to derive more thrust for each pound of propellant carried.

Electric propulsion systems may provide the power for future long duration flights, requiring engines that will operate for thousands of hours unattended or missions requiring small, precise applications of thrust. A Lewis engineer designed and developed the first ion engine flown successfully in space. In 1969 the SERT II (space electric rocket test) mission will test electric engines in space for periods up to six months.

Lewis propulsion experts are also at work on air-breathing engine technology in support of subsonic, supersonic and hypersonic aircraft. Efforts in this field are directed toward solving pacing problems associated with various air-breathing engine components; compressors and turbines, combustors, materials, bearings, seals and lubricants.

Although much emphasis in the space program is on propulsion technology, electric power generation work is equally important. For once a space-



In contrast to giant chemical engines, this small electron bombardment ion engine generates only a few millipounds of thrust. Although insufficient for initial lift-off from earth, banks of these small rockets may find a variety of uses in future space missions.

craft separates from its launch vehicle, it must depend on its own source of electricity to operate on-board systems. Solar cells which convert solar energy to electric energy continue to provide the basic source of power for most spacecraft. At one time, solar cells were subject to severe radiation damage but a radiation resistant solar cell was developed by a Lewis scientist and is used today on all satellites equipped with solar cells for power.

Other advanced power concepts include thin-film solar cells, of interest because of their light weight and flexibility. Work is also underway on Brayton and Rankine systems and their components. The Rankine cycle, similar to that used in earthbound power generating stations, heats a liquid to vapor, then superheats it and expands it through a turbine to generate electricity. A Brayton cycle, which is like a gas turbine, works in much the same way as a Rankine unit except that the Brayton system uses a gas rather than a liquid as the working fluid.

SNAP-8, a mercury-Rankine cycle with a nuclear reactor serving as its power source, is designed to provide 35,000 watts of on-board power for periods up to 10,000 hours—roughly a year's duration. (SNAP is an acronym for Systems for Nuclear Auxiliary Power.)

Another vital area of Lewis research is the field materials technology. Lewis scientists are studying applications of various materials at temperatures ranging from near absolute zero to 7,000 degrees F. Of particular interest are glass fiber-reinforced plastics with strength-to-density ratios 5 to 10 times that of common alloys. Lewis scientists also have developed a new series of nickel-cobalt alloys for high-strength applications; dispersion strengthened alloys using power metallurgy; and refractory metals with melting points beyond 4,000 degrees.

Thus research and development activities at Lewis are broad: from basic laboratory work to launch pad hardware. The Center's mission and objectives are—and always have been—predominantly propulsion and power, and the staff can point with pride to work that helped influence the outcome of World War II; helped guide the nation into supersonic flight; pioneered early rocketry; solved many complex chemical rocket problems; and continues to improve the propulsion technology available to the nation.

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